SECTION 26 2413

SWITCHBOARDS

****
LANL MASTER SPECIFICATION

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the ESM Electrical POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within “stars” during editing.

Specification developed for ML-3 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.
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Refer to LANL Engineering Standards Manual Section D5010 paragraph 2.6 for requirements applicable to using a “switchboard” as opposed to using a “power panelboard” or a “*low-voltage power circuit breaker* switchgear assembly”. Refer to LANL Construction Specifications Section 16442 *Panelboards* and Section [16426][16430] *Low-Voltage Power Circuit Breaker Switchgear*.
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PART 1 GENERAL

1.1 SECTION INCLUDES

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Edit the following articles to match project requirements.
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A. Section covers floor-mounted deadfront low-voltage switchboards which consist of an enclosure, circuit breakers, instruments, metering equipment, monitoring equipment or control equipment, with associated interconnections and supporting structures. Uses on Project include:

1. Main Switchboard - Furnish and install the service entrance switchboard(s) shown on the Drawings and specified in this Section.

2. Distribution Switchboard - Furnish and install the distribution switchboard(s) shown on the Drawings and specified in this Section.

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 3300, Submittal Procedures:

1. Calculations: Submit coordination study for switchboard prepared in accordance with IEEE Std 242 *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems*; demonstrate fully

selective coordination within switchboard and with immediate upstream and downstream overcurrent protective devices.

2. Catalog Data: Submit catalog data describing each type switchboard, circuit breaker, accessory item, and component specified. Include data substantiating that materials comply with specified requirements.

3. Certification: Submit certification and backup information that switchboard can perform required functions after a design earthquake as specified in "SERVICE CONDITIONS" below.

    a. Switchboards designated with I_p greater than 1.0 shall be certified by the manufacturer to withstand the total lateral seismic force and seismic relative displacements specified in the IBC or ASCE 7.

    b. Manufacturer's certification shall be based on shake table testing or experience data (ie., historical data demonstrating acceptable seismic performance), or by more rigorous analysis providing for equivalent safety.

    c. Required response spectra shall exceed 1.1 times the in-structure spectra determined in accordance with IBC AC156 *Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems*.

4. Certification: Submit certification by manufacturer's field technical representative that the contractor has installed, adjusted, and tested the switchboard according to the manufacturer's recommendations.

5. Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, installation, and starting of Product, including equipment anchoring requirements to meet the seismic conditions specified in "SERVICE CONDITIONS".

6. Operation and Maintenance Instructions: Submit operation and maintenance instructions including step-by-step inspection and maintenance test procedures and a listing of recommended spare parts. Include instructions for testing circuit breakers.

7. Performance Data/Curves: Submit time-current curves for each circuit breaker.

8. Shop Drawings: Submit shop drawings for each switchboard including dimensioned plans and elevations and component lists. Include front and side views of enclosure showing overall dimensions, enclosure type, enclosure finish, unit locations, and conduit entrances. Include the following:

a. Front, side, and plan view of the switchboards.

b. Single line or three line diagrams.

c. Nameplate schedule.

d. Component lists.

e. Conduit entry locations.

f. Busway entry locations and details.

g. Switchboard ratings including short circuit, voltage, and current.

h. Major component ratings including voltage, current, and interrupting.

i. Cable terminal sizes and types.

j. Shipping splits.

k. Enclosure type with details for types other than NEMA Type 1.

l. Bus configuration and current ratings.

m. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

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Edit the following articles to match project requirements; delete if not required.
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n. Key interlock scheme drawing and sequence of operations.

o. Description of the main-tie-main automatic throw-over system to include components and operating sequences.

9. Test Reports: Submit results of factory production tests specified in NEMA PB 2 and field inspections and tests required by this Section.

10. Wiring Diagrams: Submit detailed schematic wiring diagrams including device identifications and numbered terminals for power, control, communications and instrumentation systems, and differentiating between manufacturer-installed and field-installed wiring.

1.3 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in this Section are as defined in IEEE Std 100.

1.4 QUALITY ASSURANCE

A. Comply with the *National Electrical Code* (NEC) for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

C. Comply with IEEE C37.13 *Standard for Low-voltage AC Power Circuit Breakers Used in Enclosures* and IEEE C37.17 *Standard for Trip Devices for AC and General Purpose DC Low-voltage Power Circuit Breakers*.

D. Comply with NEMA PB 2 *Switchboards,* NEMA AB 1 *Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures*, and NEMA AB 3 *Molded Case Circuit Breakers and Their Application*

E. Comply with UL 891 *Dead Front Switchboards*, UL 489 *Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures,* UL 1066 *Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.*

F. Provide switchboard(s) manufactured in a certified ISO 9001 or 9002 facility.

1.5 RECEIVING, STORING AND PROTECTING

A. Receive, inspect, handle, and store switchboard(s) according to the following:

1. Manufacturer's written instructions.

2. NECA 1 Standard Practices for Good Workmanship in Electrical Construction (ANSI) and NECA 400 Recommended Practice for Installing and Maintaining Switchboards (ANSI).

3. NEMA PB 2.1 Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

1.6 EXTRA MATERIALS

A. Provide one spray can of touch-up paint that matches switchboard finish.

B. Furnish any special tools or test equipment required to operate and maintain the equipment.

1.7 SERVICE CONDITIONS

A. Provide switchboards and accessories that will perform satisfactorily in the following service conditions:

1. Elevation of 7500 feet above sea level.

2. Maximum ambient temperature of 104 °F.

3. 24-hour average temperature not exceeding 86 °F.

4. Load current harmonic factor not exceeding 5% THD.

5. International Building Code seismic criteria:

a. Seismic Design Category = D

b. S_{DS} = spectral acceleration, short period = 0.54g

c. a_p = component amplification factor = 1.0

d. R_p = component response modification factor = 2.5

e. I_p = Component importance factor
I_p = 1.5 for life safety related components such as emergency system switchboards
I_p = 1.5 for safety class or safety significant system switchboards.
I_p = 1.0 for all other switchboard applications

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Edit the following article to match project requirements; use only for outdoor equipment.
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6. Maximum solar heat gain: 110 W/sq ft.

B. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01 2500, Substitution Procedures.

2.2 SWITCHBOARD GENERAL REQUIREMENTS

A. Provide NRTL-listed enclosed switchboard that is designed and fabricated in accordance with NEMA PB 2 and has electrical ratings and configurations as indicated on Drawings or specified in this Section.

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Switchboard information required on the Drawings includes the following (from NEMA PB 2):

a. Rating of supply
    1. Voltage
    2. Number of phases
    3. Current in amperes
    4. Available short circuit-current at the line terminals of the switchboard
    5. Frequency (if other than 60 Hz.)
b. Neutral ampacity as a percentage of the switchboard ampere rating (Refer to ESM Chapter 7 Section D5010 paragraph 2.1-C.)
c. Cables
    1. Size
    2. Type
    3. Number
    4. Entry location (top or bottom)
d. Busway
    1. Entry location(s) and phase orientation
    2. Description
    3. Grounding method
e. Ground-fault protection for main and feeder circuit breakers (Refer to ESM Chapter 7 Section D5010 paragraph 2.6.2-D.)
f. Enclosure type (NEMA 1, NEMA 3R walk-in)
g. Main disconnect device (Refer to LANL ESM Chapter 7 Section D5010 paragraph 2.6.1-B for requirement to have a single main disconnect.)
    1. Type (fixed molded-case circuit breaker, draw-out power circuit breaker, etc.)
    2. Ampere rating
    3. Standard or 100% continuous current rated
    4. Poles
    5. Trip unit settings (Refer to ESM Chapter 7 Section D5000 paragraph 4.1-D.4.)
h. Feeder and branch circuit devices
    1. Type (panel-mounted circuit breaker, rear connected circuit breaker, etc.)
    2. Ampere ratings
    3. Poles
    4. Quantity
    5. Trip unit settings (Refer to ESM Chapter 7 Section D5000 paragraph 4.1-D.4.)
i. Zone selective interlocking: within switchboard, between switchboard and upstream or downstream switchboards or switchgear.
j. Intended application: service equipment, non-service equipment, separately derived system
k. Construction features
    1. Front accessible, rear accessible, front and side accessible, rear and side accessible, etc.
    2. Individually mounted circuit breakers
    3. Panel (Group) mounted circuit breakers
l. Unusual service conditions beyond those described under SERVICE CONDITIONS
m. Where working access will be available (front, rear, side)

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B. Switchboards having a main circuit breaker shall be NRTL-listed for use as service entrance equipment.

C. Provide switchboard having NRTL-listed short circuit current rating not less than the available fault current indicated on the Drawings.

D. Provide compression lugs for service, feeder, and branch circuit cable connections greater than 100 amperes; provide mechanical lugs for connections 100 amperes or less.

2.3 SWITCHBOARD ENCLOSURE

A. Provide switchboard with NEMA Type 1 general purpose or NEMA Type 3R rain tight walk-in enclosure as indicated on the Drawings or as required by the installation location.

1. Section alignment:

a. Switchboards with front accessible load connections shall have sections rear aligned.

b. Switchboards with rear accessible load connections shall have sections front and rear aligned.

2. Provide removable steel base channels (1.5 inch floor sills) bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.

3. Enclosure shall be painted on all surfaces with manufacturer's standard medium gray, applied by electro-deposition over an iron phosphate pre-treatment.

4. Front covers shall be screw removable with a single tool and doors shall be hinged with removable hinge pins.

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Edit the following article to match project requirements. Switchboards with rear connected circuit breakers and compartmented/barriered construction are considered to be more reliable and safer to maintain than those with front connections. However, rear connected switchboards are significantly more expensive and larger than switchboards with front accessible connections, and, of course, require rear access. Carefully consider costs versus benefits before specifying a rear-connected switchboard. Switchboards with main-tie-main breakers are most likely in a reliability class that warrants compartmented/barriered, rear-connected construction. The following requirements do not apply to sections with panel-mounted circuit breakers.
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B. Provide compartments and barriers in switchboard sections containing rear-connected circuit breakers.

1. Provide separate compartments for circuit breakers, distribution bus, and cable connections.

2. All incoming or outgoing busways or conduits and power conductors shall be routed through and terminated in the cable compartments. Provide adequate space for the busways or conduits that will terminate in each section.

3. Provide barriers between the circuit breaker compartment and the distribution bus compartment.

4. Provide barriers between the circuit breaker compartment and the adjacent sections.

5. Individually mount each circuit breaker in a compartment with full steel barriers at the top, bottom and sides.

2.4 SWITCHBOARD BUSSING

A. Provide switchboard with copper phase [and neutral] bus.

1. Provide full-rated, non-tapered switchboard through bus.

2. For 4-wire systems, the neutral bus shall be of equivalent ampacity as the phase bus bar unless otherwise indicated on the Drawings.

3. Switchboard bus current ratings shall be determined by heat-rise tests conducted according to UL 891.

4. Switchboards used on 480V and 480Y/277V systems shall have bus insulators and separations rated for 600V.

5. Bus connection areas shall be silver-plated.

6. All bus joints shall consist of Grade 5 hardware and Bellville washers.

7. All bolted bus connections shall be accessible for maintenance after switchboard is installed.

8. Make full provisions for the addition of future sections; include all necessary hardware to accommodate splicing for future additions.

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Edit the following article to match project requirements. The following requirement does not apply to sections with panel-mounted circuit breakers.
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9. Fully insulate bus bars in rear accessible compartments. Do not reduce spacing of insulated bus.

B. Provide copper equipment ground that extends through each switchboard section

1. Size ground bar per NEC and UL 891 but not smaller than required for mounting IEEE 837 2-hole compression lugs.

2. Provide bolt holes in NEMA 1.75-inch pattern to accept 2-hole compression lugs.

3. Bond ground bus to each switchboard section.

4. Make full provisions for the addition of future switchboard sections; include all necessary hardware to accommodate splicing for future additions.

2.5 SWITCHBOARD METERING

A. Provide electronic meter, instrument transformers, test switches and plugs, and fuses specified in Section 26 2713, Electricity Metering, in a dedicated, barriered instrument compartment.

1. Mount top of meter readout approximately 60 inches above the bottom of the switchboard.

2. Furnish NEMA PB 2 utility transformer compartment for current transformers specified in Section 26 2713, Electricity Metering.

3. Provide current transformers appropriately sized for use on the main.

4. Provide potential transformers if required by the meter.

2.6 SWITCHBOARD CIRCUIT BREAKERS

A. Provide circuit breakers as indicated on the Drawings and specified in this Section.

1. Provide circuit breakers of the type, rating, and features as indicated on the Drawings.

2. Provide 600 V rated 2-pole and 3-pole circuit breakers on 480 V or 480Y/277 V systems.

3. Provide handle lock-off device that will accept a padlock for each circuit breaker.

4. Fully equip all unused circuit breaker spaces for future devices, including all appropriate connectors and mounting hardware.

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Edit the following articles to match project requirements. Select draw-out mounted main circuit breaker where circuit breaker weight will be equal to or greater than 42 lb. Some 1200 ampere circuit breakers weigh less than the calculated 42 lb NIOSH lifting limit and may be fixed mounted. The NEC requires than a main circuit breaker 1000 amperes and greater on a 470Y/277 V system have ground-fault protection, necessitating an electronic trip unit. The LANL ESM requires that if the main circuit breaker must have ground-fault protection, the immediate downstream circuit breakers larger than 100 A also must have ground-fault protection. Zone-selective interlocking is required within switchboards with electronic trip circuit breakers. Zone-selective interlocking is also required between switchboards with electronic trip circuit breakers

and upstream low-voltage power circuit breaker switchgear. Refer to ESM Chapter 7 Section D5010, paragraph 2.6.3.
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B. Main [and tie] circuit breaker[s]

1. Provide fixed-mounted molded-case main circuit breaker if circuit breaker weight is less than 42 lb.

a. Circuit breaker shall comply with NEMA AB 1.

b. If ground-fault protection or zone-selective interlocking is required, provide electronic trip unit as described below.

c. If ground-fault protection or zone-selective interlocking is not required, provide circuit breaker with thermal-magnetic trip unit having an adjustable instantaneous trip.

2. Provide draw-out mounted main [and tie] circuit breaker[s] if circuit breaker weight is equal to or greater than 42 lb.

a. Provide molded-case or insulated case circuit breaker that complies with NEMA AB 1, or power circuit breaker that complies with IEEE C37.13.

b. Provide electronic trip unit as described below.

C. Feeder and branch circuit breakers:

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Edit the following article to match project requirements. Switchboards with rear-accessible load connections and compartmented/barriered construction are considered to be more reliable and safer to maintain than those with front connections. However, rear connected switchboards are significantly more expensive and larger than switchboards with front accessible connections, and, of course, require rear access. Switchboards with main-tie-main breakers are most likely in a reliability class that warrants compartmented/barriered, rear-connected construction. Carefully consider costs versus benefits before specifying a rear-connected switchboard.
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1. Provide fixed-mounted molded-case feeder and branch circuit breakers.

a. Circuit breaker shalls comply with NEMA AB 1.

b. If ground-fault protection or zone-selective interlocking is not required, provide circuit breakers with thermal-magnetic trip unit having an adjustable instantaneous trip.

c. If ground-fault protection or zone-selective interlocking is required, provide circuit breakers with electronic trip unit as described below.

d. Load connections shall be [front-accessible][rear accessible].

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Edit the following article to match project requirements; delete if electronic trip units are not required.
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D. Electronic trip units:

1. Provide NRTL-listed circuit breaker electronic trip units conforming to ANSI C37.17-1997 *Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers*.

2. Provide field interchangeable rating plug.

3. Trip unit shall have adjustable functions as follows:

    a. Long-time pickup and delay

    b. Short-time pickup and delay

    c. Instantaneous pickup

    d. Ground fault pickup and delay

4. Provide zone selective interlocking for each electronic trip unit. Implement zone selective interlocking between main and feeder circuit breakers within the switchboard with electronic trip units. Interlock both short-time and ground-fault time delays with upstream and downstream trip units so the circuit breaker closest to a fault will trip with no delay.

5. Trip unit shall use true RMS current sensing.

6. The following trip indications shall be visible on the front of the trip unit:

    a. Long-time

    b. Short-time or instantaneous

    c. Ground fault

7. Provide a removable and sealable transparent cover for trip unit adjustments and rating plug to comply with NEC requirements.

8. Provide neutral conductor current transformers if required for ground-fault protection.

2.7 SURGE PROTECTION

A. Provide Surge arresters connected to the line-side of the main circuit breaker; refer to Section 26 4123, Lightning Protection Surge Arresters and Suppressors, and Section 26 4313, Transient Voltage Suppressors.

B. Provide transient voltage surge suppressors connected to the main bus on the load side of the main circuit breaker; refer to Section 26 4123, Lightning Protection Surge Arresters and Suppressors, and Section 26 4313, Transient Voltage Suppressors.

C. Provide engraved laminated Category I nameplate for each device. Refer to Section 26 0553, Identification for Electrical Systems.

D. Show the entire single line switchboard bus work, as depicted on the factory record drawing, on an engraved nameplate. The nameplate plate shall be located at eye level on the front cover of the switchboard incoming service section.

2.8 CONTROL WIRING

A. Use Type SIS or equivalent high temperature wire for control and communications wiring.

B. Secure wires in bundles using nylon ties; anchor bundles to the switchgear assembly using pre-punched wire lances.

C. Connect current transformer secondary leads to accessible short-circuiting terminal blocks before connecting to any other device.

D. Terminate control and communications conductors on terminal blocks with suitable numbering strips; use crimp-on solderless lugs.

E. Provide wire markers at each end of all control and communications wiring.

2.9 SWITCHBOARD ACCESSORIES

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Edit the following articles to match project requirements; delete those not needed.
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A. Provide the following accessories, modifications, or special features for switchboards as indicated on the Drawings or as required.

B. [Provide portable, floor supported, elevating carriage with roller base, for movement of circuit breakers in and out of switchboard structure. Provide appropriate lifter bars and attachments for lifting circuit breakers.]

C. [Provide shunt-trip for circuit breaker(s) indicated on the Drawings.]

D. [Provide transformer[s] with 220 degrees F insulation and primary plus secondary fuses to provide 120 volt control power as required by: metering and monitoring system; [outdoor enclosure lights, receptacles;] [electric heaters;] [and adequate power for transformer cooling fans]. Provide fuses with blown-fuse indicators while fuse is installed in the fuse mounting.]

E. [Provide neutral bus rated 200% of the phase bus for high harmonic applications.]

F. [For switchboards installed outdoors or in damp indoor locations, provide thermostatically-controlled electric heaters in each section.

1. Provide 120V heaters, 250 watts minimum, with sufficient capacity to control moisture condensation in each section.

2. Provide industrial-type thermostat for each section to maintain 60 to 90 degrees F.]

G. [Provide key interlock systems to accomplish the following functions:

1. Prevent operation of the secondary unit substation primary switch if the 480Y/277 volt main circuit breaker is closed.

2. [Prevent paralleling of electrical sources through the main circuit breaker and future second source main breaker.]

3. Prevent closing tie circuit breaker if both main circuit breakers are closed.

4. Prevent closing both main circuit breakers unless tie circuit breaker is open.]

H. [Provide truck operated cell switch[es] to indicate racking position of the main [and tie] circuit breaker[s].]

I. [Provide for bonding of system neutral in the switchboard [for double-ended arrangement.] [to facilitate future conversion of the switchboard to a double-ended arrangement.]]

J. [Provide a bus transition section to interface with the existing _____/_____ kVA (AA/FA) [liquid filled] [dry-type] transformer[s]. Transformer[s] was [were] manufactured by _____ and is [are] shown on manufacturer's shop drawing number _____, dated _____.]

K. [Provide modified differential ground fault sensing and interruption system for main and tie circuit breakers.]

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Edit the following article to match project requirements; coordinate with Drawings; delete if automatic throw-over system is not needed. This specification describes a two-source, three breaker system used in double-ended unit switchgear for a critical facility. Less critical facilities may not require the closed transition operating sequence described in article I below. Other switchgear configurations, such as those with secondary tie circuits to separate switchgear, will

require different automatic throw-over system specifications.
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2.10 AUTOMATIC THROW-OVER SYSTEM

A. Provide a two-source, three-breaker automatic throw-over control system in the double-ended switchboard for the automatic operation of main and tie circuit breakers.

B. Furnish control system with programmable logic controller (PLC), uninterruptible power source (UPS), control power transfer relays, control switches and indicator lights to accomplish the required functions.

C. Provide a PLC to control the automatic throw-over system.

1. Provide PLC that will retain programming and data through power interruptions of four months duration.

2. Provide PLC with redundant power supplies for increased reliability. Power supplies shall meet IEEE 587, Category B requirements for surge voltage protection.

3. Provide digital input modules with not less than 2500 VRMS isolation between input terminals and logic. Each input channel shall have two LED indicators: an input LED that illuminates when the input receives an ON signal; a logic LED that illuminates when the input is correctly converted to a processor level logic signal.

4. Provide digital output modules with not less than 2500 VRMS isolation between input terminals and logic. Each output channel shall have three LED indicators: a logic LED that illuminates when module receives an ON signal from the processor; a load LED that illuminates when the output voltage is provided at the output terminals; a blown fuse LED that illuminates when a blown fuse is detected. Digital output modules shall contain a field replaceable fuse for each channel.

5. Fully document the automatic throw-over control system programming in the O&M manual. Supply backup copies of programming plus software, interface hardware, and passwords required to modify programming or re-load programming as O&M material. Provide detailed procedures for functional testing of the automatic throw-over system.

D. Provide an on-line type UPS with not less than 10 minutes of battery back-up time to power the automatic throw-over system.

E. Provide automatic control power transfer relays to transfer control power bus from one control power source to the second when the first is de-energized.

F. Provide a control panel, located on a compartment door above the tie circuit breaker, with the following features:

1. Circuit breaker control switches for each main and tie circuit breaker for manual tripping and closing.

2. Three indicator lights with legend plates above each circuit breaker control switch to indicate open (green), closed (red) and tripped on overcurrent (yellow).

3. Key operated manual-maintenance-automatic operating mode selector switch.

4. Three operating mode indicator lights: manual (red, flashing), maintenance (yellow, flashing), automatic (green) with legend plates.

5. Key operated test switch to simulate loss of voltage on either source and to permit testing of the complete automatic throw-over control system.

6. Two source available indicator lights (green) with legend plates.

7. Two control power transfer position indicator lights (amber) with legend plates.

8. Indicator lights shall be push-to-test LED pilot lights.

G. Furnish solid-state, draw-out case mounted protective relays that conform to the requirements of ANSI/IEEE C37.90, *Relays and relay Systems Associated with Electric Power Systems* as follows:

1. Two 3-phase ANSI device type 47 voltage phase sequence relays that respond to phase failure, phase unbalance and reversed phase sequence.

2. One single-phase ANSI device type 25 synchronism-check relay to determine that proper phase angle and voltage exist.

H. Provide the following open transition operating sequence for the control system in the automatic mode:

1. Normal configuration: both main circuit breakers closed and the tie circuit breaker open.

2. Upon phase reversal or loss of phase-to-phase voltage of either source to 70% of nominal, and after a time delay of 1 second (adjustable from 0.1 to 10 seconds), open the main circuit breaker corresponding to the failed source then immediately close the tie circuit breaker if voltage is available at the other main circuit breaker.

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Edit the following article to match project requirements; coordinate with Drawings.
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3. After the above operation and when the failed source has been restored to normal and synchronism check is maintained for 5 seconds (adjustable from

0.1 to 10 seconds, [automatically] [permit manual controls to] make a closed transition re-transfer: close the main circuit breaker corresponding to the restored source then immediately open the tie circuit breaker. Automatic, open transition, retransfer shall occur without time delay in the event of phase reversal or loss of phase-to-phase voltage on the source feeding the closed main circuit breaker.

4. Include provisions to prevent automatic throw-over under the following conditions:

   a. Simultaneous failure of both sources.

   b. If a main or tie circuit breaker has tripped due to overcurrent or ground fault.

   c. If tie circuit breaker is in the test or disconnected position.

   d. If mode selector switch is in the manual or maintenance position.

5. When in the automatic mode, disable the breaker control switches.

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Edit the following article to match project requirements; coordinate with Drawings. Less critical facilities may not require the closed transition operating sequence described in the following article.
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I. Provide the following closed transition operating sequence for the control system in the maintenance mode:

   1. Normal configuration: both main circuit breakers closed and the tie circuit breaker open.

   2. Operating the control switch for either main circuit breaker shall, after synchronism check, close the tie circuit breaker then immediately open the main circuit breaker corresponding to the control switch.

   3. After the above operation, operating the control switch for the tie circuit breaker shall, after synchronism check, close the open main circuit breaker then immediately open the tie circuit breaker.

   4. Include provisions to prevent the above maintenance mode operations under the following conditions:

      a. If main or tie circuit breaker has tripped due to overcurrent or ground fault.

      b. Phase reversal or loss of phase-to-phase voltage of either source.

      c. If main or tie circuit breaker is in the test or disconnected position.

J. Provide the following operating sequence for the control system in the manual mode:

1. Normal configuration: both main circuit breakers closed and the tie circuit breaker open.

2. Operating the control switch for either main circuit breaker shall open or close the main circuit breaker corresponding to the control switch.

3. Operating the control switch for the tie circuit breaker shall close or open the tie circuit breaker.

4. In the manual mode, electrically interlock the main and tie circuit breakers to prevent paralleling of sources.

K. Provide an engraved nameplate, red background with white lettering, with operating procedures for the automatic throw-over control system.

L. Provide dry contact outputs indicating the following conditions; connect contacts to the switchgear communications network through addressable relays:

1. Mode selector switch in automatic position.

2. Mode selector switch in maintenance position.

3. Mode selector switch in manual position.

4. PLC run.

5. PLC error or halt.

6. PLC battery low.

7. UPS normal.

8. UPS on battery.

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Edit the following article to match project requirements; coordinate with Drawings; delete if switchboard is to be installed indoors.
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2.11 OUTDOOR ENCLOSURE

A. Provide walk-in outdoor enclosure with the following features:

1. Full length interior aisle not less than 3'-6" wide.

2. Access/exit doors with panic hardware at each end of aisle.

3. Hinged access doors with tamper-resistant hardware and pad-lockable handles at the rear of each switchgear section.

4. Fluorescent lighting that provides not less than 30 vertical footcandles on face of switchgear 3 ft above floor.

   a. Use enclosed luminaires with 4-ft lamps and low-temperature ballast capable of 0-degrees F starting.

   b. Refer to Section 26 5100 Interior Lighting for material and installation requirements.

5. One GFCI duplex convenience outlet per 10 feet of enclosure length.

6. Thermostatically-controlled exhaust fan(s). Powered outlet dampers interlocked with powered inlet dampers. Provide 30% efficiency filters on air inlets. Provide exterior rain-proof louvers on air inlets and exhaust fan outlets.

7. Removable steel cover plates over bottom conduit entrance areas.

8. White or light gray interior paint finish.

9. ANSI #61 exterior epoxy paint finish to match University standard utility color, Fawn #3604.

2.12 SWITCHBOARD MANUFACTURERS

A. Cutler-Hammer “Pow-R-Line C” (front accessible), “Pow-R-Line I” (rear accessible).

B. Square D “QED-2” (front accessible), “QED-6” (rear accessible).

PART 3 EXECUTION

3.1 EXISTING WORK

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Delete this article when existing construction is not affected.
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A. Disconnect and remove each abandoned switchboard.

B. Maintain access to each existing switchboard that is to remain active.

C. Clean and repair each existing switchboard that is to remain or be reinstalled.

3.2 EXAMINATION

A. Examine surfaces to receive switchboard(s) for compliance with installation tolerances and other conditions affecting performance of the product. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install switchboard(s) where indicated on the Drawings and according to manufacturer's instructions, NECA 407, and the *NEC*. Have the manufacturer's installation instructions available at the construction site.

B. Provide supports and seismic anchorage in accordance with the manufacturer's installation instructions and requirements of Section 26 0529 Hangers and Supports for Electrical Systems.

C. Ground and bond switchboards as required in Section 26 0526 Grounding and Bonding for Electrical Systems.

D. Install conduits as required in Section 26 0533, Raceways and Boxes for Electrical Systems.

1. Terminate conduits in the switchboard section containing the corresponding device.

2. Install plugged couplings set flush with the top of the concrete pad. After switchgear is set in place, extend conduits to 1-1/4 inch above the pad and terminate with insulated grounding bushings.

E. Install conductors as required in Section 26 0519, Low voltage Electrical Power Conductors and Cables.

1. Train conductors neatly in groups; bundle and secure as recommended by manufacturer to withstand fault current.

2. Use compression type lugs to connect all service, feeder, and branch circuit cables greater than 100 amperes.

3. Tighten electrical connectors and terminals, including bus bar and grounding connections, according to the manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.4 IDENTIFICATION

A. Identify switchboards and install warning signs and arc-flash warning labels as required in Section 26 0553, Identification for Electrical Systems.

B. Mark floor in front of switchboards to show NEC required working space according to Section 26 0553, Identification for Electrical Systems.

3.5 FIELD QUALITY CONTROL

A. Clean, inspect, test, and energize installed switchboards in accordance with NECA 407.

B. Verify that circuit breakers are in the proper cells and that setting of solid state trip devices and current sensor taps match values scheduled on the Drawings.

C. Verify proper torque of accessible bus connections and mechanical fasteners after installing switchboard.

D. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

E. Perform acceptance inspection and tests as required in Section 26 0813, Electrical Acceptance Testing.

3.6 MANUFACTURER'S FIELD SERVICE:

A. Provide the services of a factory trained representative from the manufacturer to inspect and certify the installation and to oversee energizing and testing.

B. Manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer’s recommendations.

C. Provide one full work day of training for up to three owner’s representatives at the project site. A manufacturer’s qualified representative shall conduct training session. The training program shall consist of instruction on the operation and maintenance of the switchboard, circuit breakers, and major components.

END OF SECTION

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Do not delete the following reference information.
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FOR LANL USE ONLY

This project specification is based on LANL Master Specification 26 2413 Rev. 0, dated January 6, 2006.